

2003

POLAR RESEARCH IN TROMSØ

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POLARMILJØSENTERET



Day-time darkness and night-time daylight

Situated at almost 70 degrees northern latitude, Tromsø is well within the Arctic Circle and subject to the natural phenomena of the polar areas. The sun remains tucked below the horizon for two months from late November in this part of the world. Today, at the end of December 2003, the air is cool (−8 °C) and the light which seeps up from the southern horizon for a couple of hours around midday is a heavy blue. This is the period when the northern lights often illuminate the sky with their magical motions and silvery, green and pink light.

A pristine environment

The Arctic is full of contrasts, not only when it comes to natural regimes like the long polar night in winter and the summer's equally lengthy period of the midnight sun. The Arctic is regarded

as one of the world's last pristine wildernesses, an environment that has seemingly been little impacted by human activities. However, pollutants transported with air and sea currents to the Arctic are in fact severe threats to this unique environment: levels of several ecotoxins are alarmingly high, as measured in Arctic wildlife. This is why environmental research has amplified in Norway during recent years. The issue of brominated flame retardants and organochlorines are addressed in two research notes in this year's *Polar Research in Tromsø*.

Climate change

The polar areas have their intrinsic value, as well as being early-warning areas for climate change. Knowledge about the evolution of the past can provide valuable information for modelling future trends. The sea ice, the ocean and the fjords are important factors that need far more looking into. It is our belief that research in

and around Svalbard will contribute a great deal more to the understanding of complex global marine systems in the years to come.

Students are welcome to the Arctic!

The University of Tromsø (www.uit.no) welcomes students who are genuinely interested in Arctic studies – as does the University Centre in Svalbard (www.unis.no). In Tromsø, subjects such as Arctic biology, Arctic geology, geophysics and fishery science are available to foreign students. Certain courses on cultural and social science are also taught in English. At the institutions of the Polar Environmental Centre, a number of scientists with polar experience are happy to supervise students.

Polar Research in Tromsø

Polar Research in Tromsø is published once a year by the Roald Amundsen Centre for Arctic Research at the University of Tromsø, the Norwegian Polar Institute and the Polar Environmental Centre, Tromsø, Norway. Its aim is to describe all manner of education and research in polar (chiefly Arctic) studies at these centres and at those research institutes and companies in the Tromsø area with which these have close ties.

It is sent on request and free of charge to all persons who are interested in polar studies.

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Erratum: Front page photograph by Erling Nordøy in *Polar Research in Tromsø* 2002 showed a Ross seal.

Former Ice Streams in the Barents Sea – New Information from 3D Seismic Data

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Streams of fast-flowing ice, bordered by ice that flows at least an order of magnitude slower, are the most dynamic components of modern and past ice sheets. They have the ability to rapidly drain huge ice sheets, and play a critical role in driving abrupt changes in high-latitude climate and oceanography. Inferred from different types of data, a major ice stream in Bjørnøyrenna (Bear Island Trough) drained ice and sediments from the ice sheets centred over Svalbard, over the central Barents Sea and over the Scandinavian mainland during the Last Glacial Maximum (Figure 1; BIT). At the University of Tromsø's Department of Geology, our pilot project uses industry 3D seismic data (Figure 1; red boxes) to investigate the archives of former ice streams in the Barents Sea.

It has been an ongoing debate over the last decades when glaciers first reached the shelf edge at the western Barents Sea. The 3D seismic data from this margin show an over 2 km-long archive of glacial sediments, providing information about the geo-

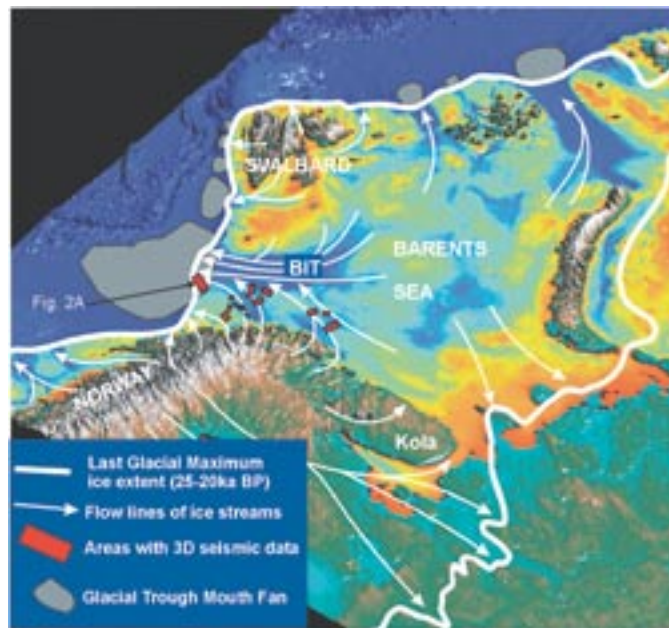


Figure 1. Map showing inferred ice extent of the Last Glacial Maximum (from Svendsen et al. in press) and areas with 3D seismic data. BIT: Bjørnøyrenna (Bear Island Trough).

logical environment since the start of the glaciation (Figure 2A). On many of the buried surfaces in the 3D data we observe km-long lineations (Figure 2B), indicating the orientation of flow lines of former ice streams. This documents that grounded glaciers reached the shelf edge in this area as early as 1 million years ago, when surface R5 was the sea floor (Figure 2). Our results suggest that these first ice streams drained from an ice sheet

that was centred over Svalbard or the central Barents Sea.

We have also been testing 3D seismic state-of-the-art mapping techniques that have never before been used on data from glacial environments, and have thereby found a tool to investigate the several hundred metres thick sediments between the glacially eroded surfaces. These results show that the ice streams have picked up over 1 km-wide sediment blocks, transported them to the shelf edge where they have been dumped, and at the same time leaving behind long chains of sediment blocks. These results document the potential of ice streams for so-called large-scale glaciotectionic erosion, providing new information about their dynamics.

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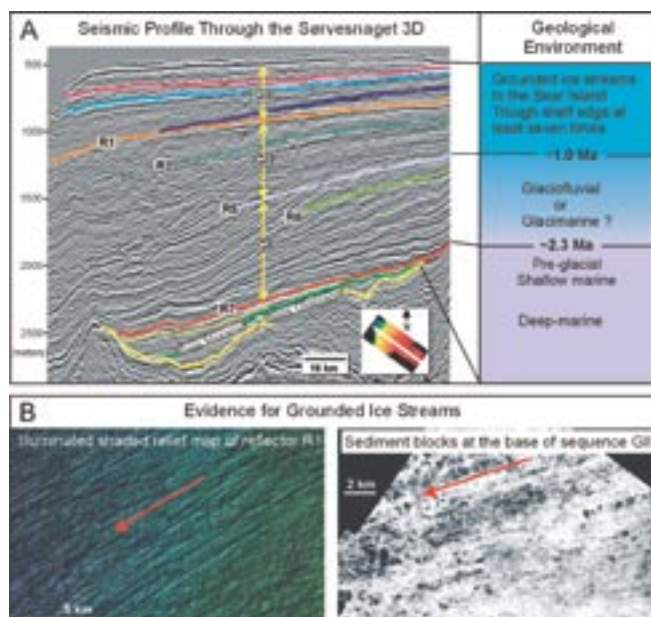


Figure 2
A. Seismic profile through the 3D area (marked 2A in Figure 1) and interpreted geological environment. The buried surfaces R1, R2, R5, R6 and R7 and age estimates are from Faleide et al. (1996). B. Shaded relief map of surface R1 showing glacial lineations (left), and RMS Amplitude map showing large chains of sediment blocks just above surface R5, both indicating flowlines of former ice streams (flow directions indicated with red arrows).

Mapping Local Climate Variation in East Greenland

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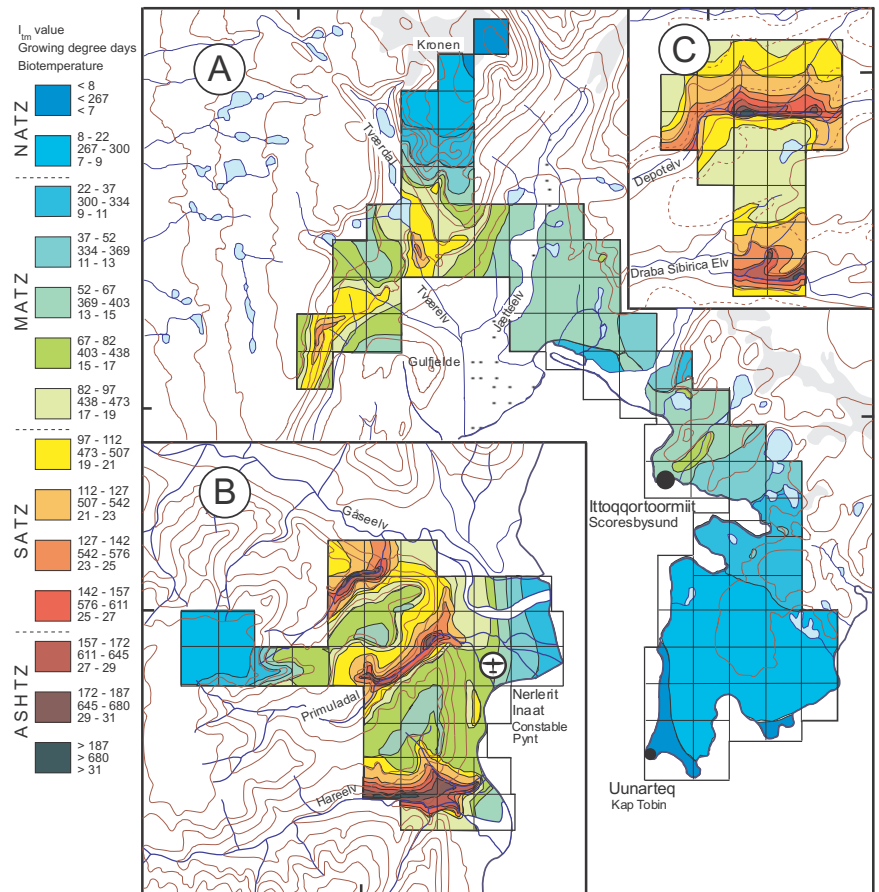
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East Greenland is an extremely sparsely populated area and experiences a very cold climate due to its exposure to the northern sea current. However, there is a very strong gradient from the cold coast to warmer sites further inland. This gradient was studied near Ittoqqortoormiit/Scoresbysund, as a part of the development of a bioclimatic method.

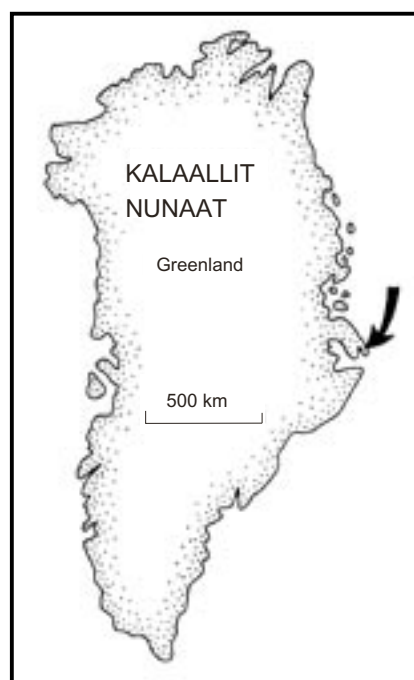
Arctic vascular plants are strongly dependent on climate and can be considered to represent different classes of temperature indicators in an Arctic context. Recording all such species within a 1 by 1 km grid pattern results in index values for all grids where high values indicate high numbers and high abundance of plants requiring relatively high temperatures within an Arctic context.

To verify if these index values really reflect temperature conditions, temperature sums during the growth period were measured at different sites during a cold and a relatively warm year, in addition to using data from four meteorological stations. The results were very promising: there was a strong positive correlation between the botanic results and the measured temperatures (r^2 values from 0.82 to 0.99).

The map shows how temperatures range from the cold coastal area at Uunarteq (with mean July temperature of 2.7° C, the world's coldest traditional community during summertime) to the warm areas (mean July temperatures almost 10° C) further inland. Uunarteq is so strongly affected by cool sea air, fog and wind that the temperature is as low as at a 1100 m tall mountain only 20 km further inland. In mainland Norway, such an altitudinal replacement of climates takes place along a distance of 1300 km, equivalent with the north-south alpine treeline displacement, as seen from the forest limit gradient. The climate gradient is even stronger at five deep and protected valleys



Map of local climate variation within three subareas studied near Ittoqqortoormiit in East Greenland. Colours ranging from blue to brown indicate increasing temperature sums, and the abbreviations on the left indicate names of four of the five bioclimatic subzones recognized from the Arctic: northern, middle and southern Arctic tundra zones, and the Arctic shrub-tundra zone. Biotemperature is the sum of all monthly mean temperatures above zero.



which capture and store warmth very efficiently as compared with surrounding areas. The horizontal climate gradient showed here is the strongest terrestrial one known from the entire Arctic.

The method has proved to work very well, but requires intensive field-work by qualified botanists. The next steps are to replace plant species by vegetation types and cover larger areas (Varangerhalvøya, north-east Norway) and combine the botany methods with remote sensing data and digitized terrain models. The botany method is considered very promising as ground truthing for remote sensing data, which have many shortcomings due to the momentary time of recording and the effects of various surface structures. A combination of methods can hope-

fully combine both accuracy and large area coverage. Understanding existing sharp climate gradients is useful for predicting future effects.

Figures reproduced with permission of the Journal of Biogeography; see Karlsen, S.R. & Elvebakk, A. 2003: A method using indicator plants to

map local climatic variation in the Kangerlussuaq/Scoresby Sund area, East Greenland, vol. 30, pp. 1469-1491.

Atmosphere–Ice–Ocean Interaction Studies on Svalbard fjords

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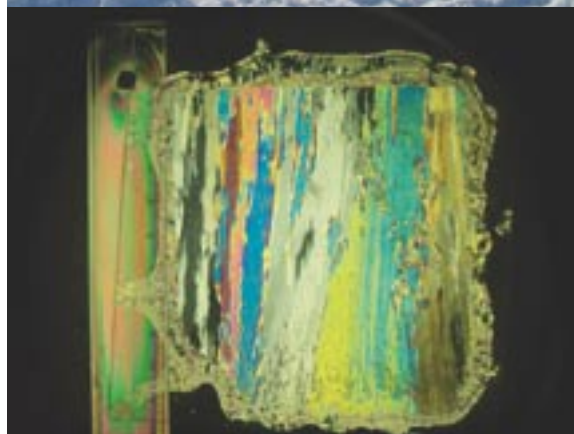
The inner parts of fjords at the western coast of Spitsbergen are covered by land-fast sea ice in winter and spring. Due to the influence of warm Atlantic water – transported to the archipelago by the West Spitsbergen Current – the timing of ice formation in these fjords is delayed compared with locations in Arctic Canada, and the ice is less thick. Ice formation in West Spitsbergen fjords also depends on their orientation, shape and size. One example of this is the largest fjord, Isfjorden, which usually develops fast ice only in its inner part and in smaller connected fjords, such as Billefjorden. Another is Kongsfjorden, located north of Isfjorden. Kongsfjorden regularly has a fast ice cover in its inner part, where a group of islands and shallow water ease ice formation (Gerland et al. 1999; Svendsen et al. 2002). The warm water influence allows ice formation usually not before mid-winter or later, and the ice's thickness is only around 70 cm. In contrast, in Van Mijenfjorden, ice formation starts earlier because the fjord is well protected by an island, Akseløya, and water exchange is limited to two narrow straits north and south of that island. Here, the fast ice usually becomes thicker than 1 m. After the onset of melt in late spring, the reflectance of snow and ice surfaces drops drastically, contributing to the melting of the ice (e.g. Winther et al. 2001).



The AIO research site on the fast ice of inner Kongsfjorden, Svalbard. Foreground: electromagnetic ice thickness profiling. Background: tent for under-ice turbulence monitoring equipment and snow machines for travel between Ny-Ålesund and the research site.



The setup for surface reflectance measurements in the field (here in April 2003 on Kongsfjorden). The downlooking optical sensor on the tripod is connected with an optical fibre to the spectroradiometer.



A vertical thin section of fast ice, seen between crossed polarizers. The different crystals appear in different colours. That section with columnar ice is from the bottom part of a core, obtained in April 2003 in Kongsfjorden. The shape and size of the crystals give information about the freezing conditions during ice formation.

In the project Atmosphere–Ice–Ocean Interaction Studies (AIO), funded by the Research Council of Norway, groups from the University of Bergen (UiB), the Norwegian Polar Institute (NPI), the University Centre in Svalbard (UNIS), the Norwegian

Institute for Air Research (NILU), the University of Washington and the McPhee Research Company, the complex natural processes controlling ice formation, freezing, melting, and break up are investigated in detail. The fieldwork for these studies runs

in Kongsfjorden, Van Mijenfjorden and Storfjorden. UiB, UNIS and the American project partners focus especially on the hydrographic conditions during ice formation and melting, by applying high resolution turbulence measurements in the upper layers of sea water. At the same locations, NPI and NILU investigate ice thickness development and the role of the ice and upper water layers in reflecting, scattering and attenuating solar radiation. Those processes are crucial for the energy balance at the atmosphere–ice–ocean interfaces.

In April and June 2003, detailed optical measurements were performed on fast ice in the inner part of Kongsfjorden. By using advanced spectroradiometers (measuring solar radiation from 350 nm to 2500 nm wavelength), surface reflectance and transmittance of ice and upper water layers were recorded under different ice conditions. Further, ultraviolet radiation was measured above and below the ice. Physical properties of the ice and its texture were also recorded.

First results reveal that the thickness of the snow layer which covers the fast ice and mild weather events in early spring before the onset of melt influence melting and ice break-up. Such mild events can lead to snow melt near the surface. Subsequent re-freezing of the resulting melt water, further downwards in the snow layer, creates another ice layer on top of the original sea ice. We compared the reflectance for solar radiation of the different surfaces and also compared our results with observations from previous years. Though there are few detailed comparable investigations from previous years, we see indications that the formation of these additional ice layers varies strongly interannually.

In 2004, the AIO field activities will consist of two larger campaigns on Van Mijenfjorden. First, during freezing in March, detailed studies of the ice and the hydrographic processes beneath the ice will be carried out and stand-alone automatic monitoring equipment will be installed. In June, the monitoring equipment will be re-

covered during a second campaign, supported by the Norwegian coast guard.

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The Influence of Ultraviolet Radiation and Climate Conditions on Fish Stocks: A Case Study of the Northeast Arctic Cod (UVAC project)

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The Northeast Arctic cod (*Gadus morhua*) stock in the Barents Sea is one of the world's commercially most important wild fish stocks. Effective management is indispensable to maintain this valuable natural resource at a viable level. Quota determinations are based on annual assessments of the year class sizes, mainly by empirical estimates derived from Barents Sea surveys. Although today's methods to measure and predict cod year classes are assumed to be quite advanced, recent experiences with relatively large discrepancies between predictions and actually measured stock highlight the importance of a deeper understanding of the factors

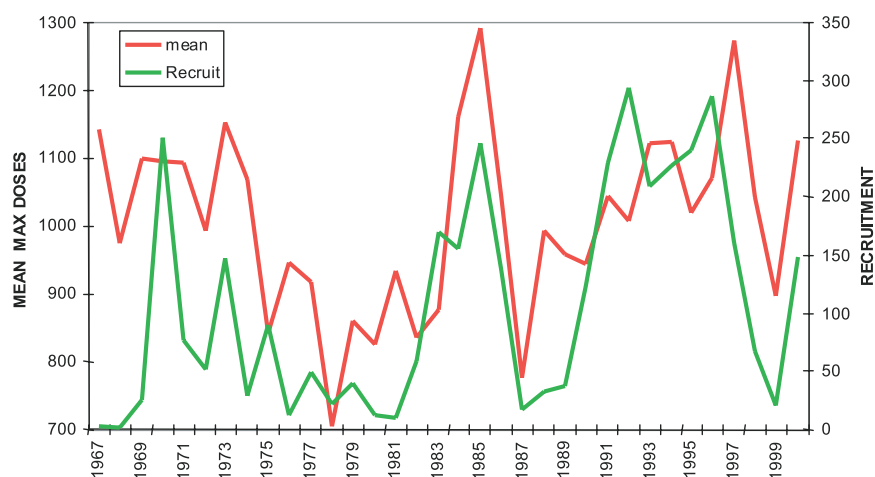


Figure 1. Comparison between the mean maximum doses of UVR (around 1 April and 1 May) in Tromsø from 1967 to 2000 (red), and cod recruitment (green). The data indicate a significant positive correlation between maximum UVR daily doses and cod recruitment.

and processes regulating the cod stocks. It is evident that if year class size is influenced by biological and physical–biological mechanisms active at an early development stage, studies of feeding conditions

(phytoplankton–zooplankton–cod interactions) and the impact of the geophysical environment (water temperature–solar ultraviolet radiation ([UVR]–climate), both on juvenile cod and its prey, should be included

in a study aimed at detecting factors that regulate year class size.

The EU-funded UVAC project was coordinated by the Norwegian Institute for Air Research and had partners from Norway (Norwegian College of Fishery Science in Tromsø and Bodø College), Spain, Germany and Italy. The main objective of the project was to investigate the impact of solar ultraviolet radiation on the Northeast Arctic cod stock. This was planned as part of a more comprehensive impact study, including other geophysical factors such as sea temperature and water turbulence, and biological factors, e.g. feeding conditions. It was envisaged to study the impact of geophysical factors both statistically, using long-term biological and geophysical data records, and in-depth in dedicated field and laboratory experiments. A second major objective was to develop modelling tools which would be capable of estimating cod stock size based on geophysical information available from remote sensing and ground-based monitoring, thus providing a more reliable basis for the sustainable management of marine resources.

The UVAC project was carried out during a 3-year period starting in March 2000. It achieved most of the aims envisaged, in some aspects beyond the expectations, in others not fully to the expected scope:

- A set of fully homogenized time series of yields in tonnes for Northeast Arctic cod from 1830 to 1999
- Cod 0-year-class and 3-year class data back to 1967 and 1946, respectively
- Data series on two *Calanus* spp. from Saltfjord and Mistfjord 1946–2000
- Sporadic data on phytoplankton since the 1940s
- Meteorological data from Skrova, Lofoten, since 1934, from Røst (1880–1969, 1979–1997) and Skomvær (1970–1978)
- Daily total ozone data (March, April and May) and derived UVR (5 parameters) and PAR data back to 1936
- Two independent satellite-derived UVR climatologies for the periods

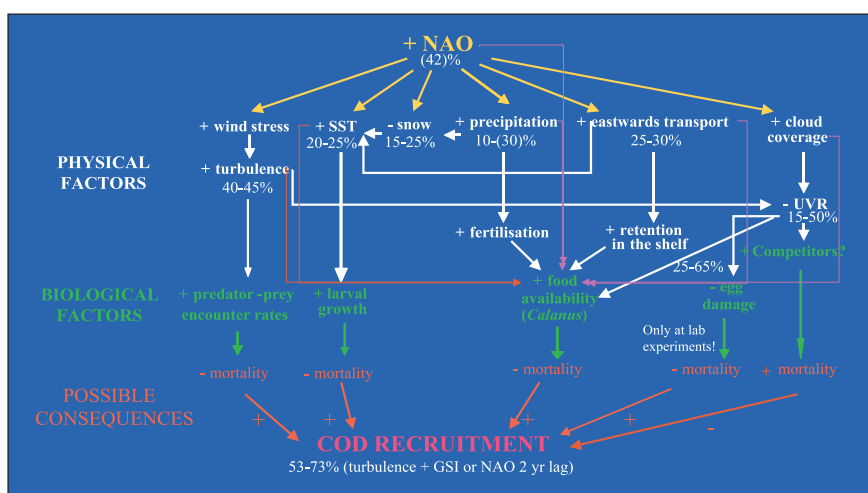


Figure 2. A sketch of the conceptual correlation study model developed based on the results from the UVAC project, i.e. potential relationships between the variables and the demonstrated correlations obtained, with the level of explained variability.

1984–2002 and 1990–2002, for the research area and beyond; inter-comparison and validation with ground-based data

- A large set of new radiation, oceanographic and marine–biological data from 10 field surveys during two spring seasons (2000, 2001) plus laboratory experiment data
- A comprehensive set of correlation studies between geophysical and biological data sets
- A wavelet analysis of three of the biological (fish yield, roe, liver) and three of the geophysical time series in which multi-annual signals are identified and their phases determined
- A conceptual model on climate impact on 0-year class cod and its food web
- Process model on UVR exposure of marine species, based on measured oceanographic and meteorological data, and derived UVR data

The most important outcome of the project was that the multi-decadal correlation studies did not yield any evidence of a negative ultraviolet influence. This was contrary to the basic initial assumption — that UVR is an important geophysical factor for cod in its earliest life stage. In fact, between some parameters, namely the maximum daily ultraviolet dose around 1 May and the 0-year class strength, a positive correlation was found, as shown in Figure 1.

Process modelling of the exposure of cod eggs and larvae to UVR, using oceanographic and meteorological data gathered during the project, showed that only in a few years (1–2 out of 20) UVR intensity in the uppermost water layer reaches levels that may seriously damage cod eggs and larvae. This occurs during coincidences of clear sky, low ozone values and slack wind, so that most of the eggs and/or larvae are at the water surface. The positive correlation between UVR and recruitment has yet to be explained.

On the other hand, project results indicated a number of other significant relations between climate parameters and cod recruitment. In particular, the North Atlantic Oscillation has an important influence on the 0-year class strength, both in the same year, with a 2-year lag and indirectly via the main prey of cod larvae, *C. finmarchicus*. The various impact mechanisms are shown in Figure 2. These results of the multi-linear correlation between climatic and biological data, in combination with wavelet analyses of the historical cod and climate data allow for the development of predictive tools on annual and decadal time scales, should the stock recover its biological potential in the future.

Moreover, the results and new data sets produced by the UVAC project have the potential to be used in a number of other studies focusing on the impact of UVR and climate on marine and terrestrial ecosystems.

Sons or Daughters? Glaucous Gull with High Levels of Organochlorines Produce Too Many Sons

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Glaucous gulls. Photo: J. O. Bustnes

Transportation via air and ocean currents has introduced several persistent organochlorine (OC) pollutants, such as the PCBs (polychlorinated biphenyls), into marine ecosystems in the Arctic, where they accumulate through the food chain. In the Svalbard archipelago, which includes Bjørnøya, high levels of organochlorines cause adverse effects on the reproductive performance and adult survival of glaucous gulls *Larus hyperboreus*.

The most common gull species in the Arctic, the glaucous gull, has a circumpolar distribution. It is a top predator in the Arctic ecosystem. During the breeding season the diet consists of invertebrates and other seabirds, including seabird eggs and chicks. Seabirds deposit some of their OC burden in their eggs. Therefore, glaucous gulls feeding on eggs are potentially at risk to accumulate heavy loads of such pollutants. Glaucous gulls are generally territorial, monogamous and sexually dimorphic, males being approximately 15% larger than females. Such dimorphism may lead to different costs of rearing male and female offspring. The expectation is that breeding females in good body condition should increase their effort in producing male offspring while females in poor body condition should not. Contrary to expectation, glaucous gulls on Bjørnøya with high blood levels of organochlorines produce an excess of sons and females with low OC levels overproduce females (Fig. 1). This seems odd as a number of studies on Bjørnøya have demonstrated that the

observed levels of OC contamination do in fact adversely affect glaucous gulls. For example, females with high loads of PCBs and other OC compounds have increased parasite loads, suffer reduced breeding success and increased adult mortality.

A fundamental question is why females with high loads of OCs do the opposite of what would be expected from current theories of optimal investment with respect to sex ratio. Although it is well established that birds are able to control the sex ratio of their offspring, the mechanisms are poorly understood. One likely explanation is that the level of OCs directly affects the endocrine function of breeding females and interacts with maternal steroids that have been suggested to determine sex ratio modifications through a non-Mendelian segregation of the sex chromosomes. Organochlorines have the potential to act as an endocrine disrupter by mimicking steroids and binding to hormone receptors. There are a number of reports on their effects on embryo development resulting in alterations in gonads, accessory sexual organs and behaviour. There are also reports on their effects on sex ratio in humans. Some studies in fact show overproduction of sons. Although the mechanisms are not

known, these studies also point in the direction of endocrine disruption. High exposure of men to OCs seems to be associated with low testosterone or high gonadotropin levels known to partially control sex ratio in humans.

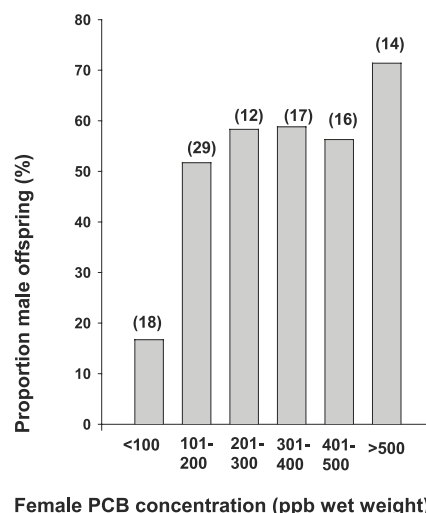


Figure 1. The likelihood that female glaucous gulls (43 broods) on Bjørnøya produce sons in relation to their total concentrations of organochlorine (OC) compounds in the blood (ng g⁻¹, wet mass). Concentrations of OC compounds consist of the sum of the persistent PCB congeners 99, 118, 138, 153, 170 and 180 and hexachlorobenzene (HCB), pp'-dichlorodiphenyldichloroethylene (DDE) and oxychlorodane.

If the suggested scenario is correct, the question remains as to why glaucous gull females with low levels of OC overproduce daughters. This result is in accordance with a selection in favour of the less common sex at the population level. Since an effect with high loads of OCs will bias the sex ratio towards males at the population level, females with low levels of OCs may benefit from producing the rare sex (females). This suggests that a flexible and adaptive strategy in response to the sex ratio at the population level is adopted by females with low OC levels.

The observed skew in sex ratio is alarming and could also affect

other species than birds. Data on evolutionary effects of sub-lethal exposure to OC contamination are still exceedingly scarce and more research is needed. Environmental changes due to pollution are generally reversible, but evolutionary changes are often irreversible. Consequently, such effects may be more serious than other environmental changes caused by pollution.

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Bearded seal in Svalbard. Photo: G.W. Gabrielsen

Brominated Flame Retardants: Exposure and Accumulation in Arctic Animals

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Industrial chemicals, particularly PCBs and pesticides like DDTs, have been a major environmental threat for several decades. As these compounds are difficult to break

down, they accumulate through the food chain, ultimately exposing top predators to high levels of toxic chemicals. Thanks to international restrictions on the production and use of these compounds, levels seem to be declining in the Arctic environment. However, while manufacturing and application of these hazardous compounds are limited by international agreements, other

potentially dangerous compounds – like polybrominated diphenyl ethers (PBDEs) – are still manufactured. These industrial chemicals are routinely used as flame retardants in many consumer products such as computers, TV sets, airplane and car seats and clothing. Approximately 70 brominated flame chemicals account for a global consumption of 300 000 tonnes per annum. An estimated 50

tonnes per year are used in Norwegian production.

PBDEs are chemically very similar to PCBs: they are transported over long distances, they are persistent and they accumulate in fatty tissues of animals. As a result they are effectively transferred through food chains. In addition, similar toxic effects as caused by PCBs have been described for PBDEs, with impacts on hormone and immune systems being the most important and destructive.

While PCBs and pesticides seem to be declining in the environment, PBDE concentrations in wildlife are on the rise. Although levels in the Arctic are still relatively low, a study in Canada showed a dramatic increase over a period of 15 years. Generally, a doubling every five years seems to be the rule. These "PCBs of the 21st century" may, without proper restrictions, cause an environmental disaster as bad as the PCBs. Sources of environmental PBDE contamination include leakage from consumer products and industrial facilities that manufacture PBDEs as well as from disposal sites of products containing PBDEs. The bioaccumulation of some PBDEs (for example, congeners 47, 99 and 153) can be similar or higher than that of PCBs in some animals. PBDE congeners 47, 99 and 100 show particularly high biomagnification in fish-eating birds and mammals. Because these animals are usually long-lived and feed high in the food chain, they are very sensitive to the effects of contaminant exposure in general and PBDE exposure in particular.

In response to the alarming increase of environmental PBDEs, the Norwegian Polar Institute launched one of the first investigations on the occurrence and persistence of PBDEs in the European Arctic. Seabirds and marine mammals were studied to investigate if, and to what extent, these compounds pose a threat to wildlife in the Arctic.

In glaucous gull (a scavenger-predatory species) from Svalbard, PBDE 47 and 99 were found in both liver and intestinal content. Measurements showed the presence of PBDE 100, 153, 190 and other congeners. The concentrations of PBDEs were 10



Glaucous gull chick on Bjørnøya, Svalbard. Photo: K. Sagerup

times lower than the concentration of PCB. The finding of many different PBDEs in seabirds may indicate long-range transport of the components and bioaccumulation via feed, a limited capability to excrete these compounds and subsequently metabolism via debromination.

In ringed seals and beluga whales, over 20 PBDE congeners were measured. PBDE 47, 99 and 100 were the dominant congeners, with PBDE 47 the most prevalent in both species. Levels found were about 10-20 times higher than in Canadian seals and whales, but substantially lower than in seals from more southern latitudes. A similar geographic distribution for persistent contaminants was also found for PCBs. The relatively high levels in the European Arctic compared to the Canadian Arctic are probably due to a more effective PBDE transport from lower latitudes to the European Arctic. Calculations on the persistence of PBDEs suggested that PBDE 47 and 99 were persistent in both ringed seals and beluga whales, while PBDE 100 was persistent in beluga whales only. Overall, more different PBDE congeners could be detected in beluga whales and this is probably caused by their relatively limited capability to metabolize these compounds.

As the apex predators of the Arctic ecosystem, polar bears usually have the highest levels of contaminants. Surprisingly, however, only PBDE 47 could be detected in both male

and female bears, in relatively low concentrations. Polar bears have a remarkable capability to metabolize a wide range of contaminants and the current results suggest an effective metabolism of most PBDEs, including PBDE 47, in this species. However, because of the polar bear's effective conversion of industrial compounds into metabolites, research on the toxicity and persistence of these reaction products is essential.

The Norwegian Government has adopted a new action plan to substantially reduce emissions of brominated flame retardants. The ban covers the use of penta-, octa- and decabromodiphenylether. The Pollution Control Authority in Norway will draft regulations prohibiting the use of penta- and octa-BDE from 1 July 2004, which is similar to the EU directive. A prohibition of deca-BDE will probably be in place by 1 January 2005.



NPI basecamp in Dronning Maud Land. Photo: Tor I. Karlsen

Norwegian Polar Institute: 75 years on call for Norway

As a result of Norway gaining sovereignty over Svalbard, the Norwegian national assembly decided to establish Norges Svalbard- og Ishavsundersøkelser (Norway's Svalbard and Arctic Ocean Survey, NSIU) in 1928. Twenty years later the name was changed to Norsk Polarinstitutt (Norwegian Polar Institute, NPI), after its geographical scope had been broadened to encompass Norway's Antarctic dependencies. In 2003, the Institute celebrated its 75th anniversary in style.

NSIU/NPI were and are Norway's central means for collecting and disseminating knowledge related to our polar regions. In the early days, the Institute's role was shaped by the need to underscore Norwegian sovereignty on these regions. The international geopolitical climate has evolved since then, but new challenges have arisen. According to the Institute's director, Olav Orheim, the need for advice from the NPI has never been greater than today.

During the last decade the Institute has undergone major transformations, especially connected to the relocation

from Oslo to Tromsø and the establishment of the Polar Environmental Centre and Polaria Visitors' Centre. The future will probably include more focus on developments in the whole Barents Region, with an emphasis on collaboration with Russia following the development of oil and gas exploitation in the country's north-western regions.

Today the Norwegian Polar Institute is firmly established with its main office in Tromsø, and a Svalbard office in Longyearbyen. The permanent staff comprises 85 persons in research, environmental management and mapping, logistics, administration and information services. The institute operates four stations: Sverdrup Research Station and Zeppelin Station for Atmospheric Monitoring and Research in Ny-Ålesund, Svalbard, and Troll and Tor (summer field station) in Dronning Maud Land, Antarctica. The Norwegian Polar Institute also owns the ice strengthened research vessel *Lance*.

Most of the Institute's research is concentrated on climate/glaciology, ecotoxicology and biodiversity; other

programmes include geology and topographic mapping. The Institute also commits significant resources to its role as a central advisor in polar affairs, especially within environmental management and by producing information on polar questions both for the Norwegian central administration and the government and for the general public.

In addition to the Institute's official web site, other sites are maintained by NPI staff. As part of the anniversary celebrations, a data base containing over 16 500 Svalbard place names was made available on the web. See <http://miljo.npolar.no/placenames>

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Hanna Resvold Hansen, first Norwegian female scientist, with topographer Karl J. Haavind and geologist Adolf Hoel during the Svalbard expedition 1906-07. NPI photo library.

Norwegian Polar History: three volumes on their way

At the Department of History, University of Tromsø, efforts to mount a thorough account of Norwegian polar history is proceeding apace. The result will be three large volumes – 450 abundantly illustrated pages – detailing Norway's involvement in the polar regions. For the international market, a single-volume English language edition is planned.

With the Norwegian renowned publishing house Gyldendal Norsk Forlag on the team, editors Einar-Arne Drivenes and Harald Dag Jølle expect a broad distribution of the work. Leading experts within many different disciplines are contributing, and six Norwegian ministries have granted financial support, in addition to The Research Council of Norway and private companies and organizations. The three volumes will appear in the autumn of 2004 and the English edition in 2005.

The work paints a more comprehensive picture of Norwegian polar activities than has ever been done before, and Norwegian activities will be seen through the lenses of traditions and developments in other countries. Questions will be raised asking if there in fact exists a Norwegian and/or Scandinavian polar tradition, and if Norwegian expedi-



Fram - legendary vessel used by Norwegian polar explorers F. Nansen, O. Sverdrup and R. Amundsen. NPI photo library.

tions have been more successful than those from other countries.

The editors aim at revisiting the great expeditions, scientific expeditions, commercial and political aspects in the Arctic and Antarctica from 1672 to today. The first volume deals with the expeditions, including Fridtjof Nansen across Greenland and towards the North Pole and Roald Amundsen's voyage through the North West Passage and towards the South Pole. Even today's modern skiing journeys to both the North and South Poles are looked at. Volume 2 is named "Challenges for Science". The public was interested in the heroic and competitive sides of the great expeditions. So how much

was science and how much was to promote national interests? Were polar studies Norway's main scientific attraction? The relationship between polar research and other forms of science is also a key topic in this volume. The third volume addresses economic activity, examining sealing and whaling from the earliest days to today. Polar tourism is also examined.

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Antarctic Airstrip

Dronning Maud Land Air Network (DROMLAN) is an international project to establish an airstrip for landing heavy aircraft on the blue ice near Troll, the Norwegian base. Norwegian Polar Institute personnel spent the 2002-2003 season constructing the airstrip; work on the three kilometre long airstrip will be completed in the 2003-2004 season. Detailed air and landing maps and a digital terrain model of the area are being prepared by the NPI. The airstrip will facilitate access to several bases in the area.

First Norwegian Minister in the Antarctic

Norwegian Minister of the Environment, Børge Brende, arrived in Dronning Maud Land on 25 January 2003 as the first Norwegian minister ever to visit the Antarctic continent. He was accompanied by NPI director Olav Orheim. Later in the year the Ministry granted NPI the means to upgrade the Troll base to a year-round research base.

Name Committee for Norwegian Polar Regions

The Name Committee for Norwegian Polar Regions was re-established in 2002 after having been a "sleeping" committee for some years following the move to Tromsø by the Norwegian Polar Institute, which is heading the committee. The University of Tromsø/Tromsø Museum is also represented. One of its main tasks has been to acknowledge and approve new names proposed during the last years, and to alter others, so as to avoid misunderstandings. In 2003, the reference book *The Place Names of Svalbard* appeared in a revised edition and the information was also made available on the Internet (see p. 11).

Ancient Logbooks Provide New Insight on Climate Change

In February 2003 the Arctic Climate System Study (a core project of the World Climate Research Programme) published its Historical Ice Chart Archive. The archive of sea-ice charts,

created by the Norwegian Polar Institute and the Norwegian Meteorological Institute – and published with funding from the World Wide Fund for Nature (WWF) – provides some of the oldest records of climate change observations in existence, covering an area from Greenland in the west to Novaya Zemlya in the east. Data for the more than 6000 maps come from modern research as well as from logbooks of long dead Arctic explorers – from as early as 1553.

Marine Birds on the Agenda

The Conservation of Arctic Flora and Fauna's (CAFF) Circumpolar Seabird Expert Group met in Tromsø to discuss research and environmental management issues related to Arctic marine birds. Following this meeting, Russian–Norwegian collaboration on marine birds was on the agenda. In co-operation with Russian partners and at the behest of Norwegian and Russian authorities, the Norwegian Polar Institute will undertake a vulnerability assessment for seabirds/oil for the eastern part of the Barents Sea. Steps will be taken toward establishing a joint monitoring programme for marine birds.

The Barents Sea is an important region for marine birds. It has one of the highest densities of birds worldwide, with over 20 million birds in summer.

Norwegian–Russian Polar Bear Co-operation

Polar bears are threatened by global climate change and in the Barents Region environmental toxins are also a cause for concern. The bears in and around Svalbard belong to a population that travels broadly through the northern Barents Sea, in Norwegian and Russian territories. The Norwegian–Russian Environmental Commission has initiated a cooperative research programme to estimate the abundance of polar bears in the northern Barents Sea. The Norwegian Ministry of the Environment has granted the Norwegian Polar Institute 4.5 million NOK to conduct this work. Currently the

population is thought to be between 2000 and 5000 animals, but the population as a whole has in fact never been surveyed.

Eleven Ministers of the Environment on Field Trip

Norwegian Minister of the Environment, Børge Brende, invited ten of his colleagues to a cruise in Svalbard waters on board the Norwegian Polar Institute research vessel *Lance* in August 2003. The ministers came from South Africa, Iceland, Canada, Denmark, Sweden, Great Britain, Russia and China. USA was also represented, as was the UN. Main topics of discussion were the environmental situation in the Arctic and the vulnerability of Arctic nature with respect to environmental changes and climate change.

International Conference

"Arctic–Alpine Ecosystems and People in a Changing Environment" gathered 200 participants from 19 countries at the Polar Environmental Centre in February 2003. The topics of the conference included contemporary environmental problems under the fields of climate change and ecosystem response, long range transport of pollutants and ozone/UV radiation and biological effects in marine and terrestrial environments.

This was a Euro Conference supported by the European Commission, and many institutes conducting polar research in Tromsø took part as organizers. It served as the final conference of the European Network for Arctic–Alpine Multidisciplinary Environmental Research (ENVINET), the final conference of the Nordic Arctic Research Programme (NARP), the last user meeting of the Ny-Ålesund Large Scale Facility, the final workshop of the EU-project UVAC (see p.9) and the first conference of the Arctic Seas Consortium. As a result of the conference a monograph will be published in 2004, as well as articles in special issues of the peer-reviewed journals *Polar Research* and *Arctic, Antarctic and Alpine Research*.





Per Savio and Ole Must



With sledges across Greenland's ice 1888

Saamis in Polar History

"In Norway, the Lapps were the first to make use of skis..." In his book *The First Crossing of Greenland*, Fridtjof Nansen stated that Norwegians in early times regarded the Saami people as the more competent skiers, and that moving rapidly across great distances on skis was a forte of the Saamis. He also praised them for their ability to master the climatic and natural conditions of polar regions, which explorers profited from. On his expedition to the North Pole, Roald Amundsen made use of fur coats, fur boots and sleeping bags made by the Saami woman Margrethe Lango.

The Swedish professor Nils A. Nordenskiöld was the first to hire Saamis as expedition members. For his expedition to Svalbard in 1872, 40 reindeer were purchased and four Saamis were hired to take care of them. Although they were only mentioned by their first names, Nils Mathisen Sara has later been identified.

In 1883, Nordenskiöld hired the two Saami men Pava Lars Tuorda and Anders Rossa as he headed for western Greenland. The aim was to reach the middle parts of the Greenland glacier. When the expedition had to turn around, the Saamis continued

on skis inwards on the glacier. Tourda, who had reconnoitred and marked out the course, made observations with a thermometer and an aneroid barometer. They returned after 57 hours, having continued 230 km beyond Nordenskiöld's turning-point and reaching a height of 1947 m.a.s.l. Posterity has been somewhat doubtful as to the actual distance covered, but for those who know of the reindeer herders of the period – who could ski for days and nights with little food and rest – this achievement seems possible.

When Nansen crossed Greenland on skis in 1888, he invited Saamis Samuel Balto and Ole Nilsen Ravna to join the expedition. After the one and a half month long journey across endless distances of ice, the expedition members had little strength left. Ravna took an extra burden on his shoulders. As they reached the west coast, Balto and Sverdrup built a boat of canvas in which they sailed southwards to Godthåb (Nuuk). Upon their return to Christiania (Oslo), a large audience waited to salute them. Nansen remarked, "Isn't this a lovely sight!" The reindeer-owner Ravna answered: "If only they had been reindeer."

In 1898 the British ship *Southern Cross* headed south for Antarctica, led by a Norwegian, Carsten Borchgrevink. Among the expedition members were Per Savio and Ole Must, who took care of the dogs. The journey went well, and due to a mishap, the two Saamis were the first to spend the night on the Antarctic continent. In his report, Borchgrevink praises the two men, who were excellent hunters. They sewed Saami fur boots and fur clothing, and "... I don't think any leader could wish for more faithful and devoted escorts than these two."

Saamis Per Hansen, Johannes Kemi and Samuel Klemmetsen participated in the search for lost members of the German Schröder-Stranz expedition in Svalbard in 1913, as members of the Norwegian Arve Staxrud's rescue expedition.

Written by Ann K. Balto (balto@npolar.no), photo librarian at the Norwegian Polar Institute. These photographs and more like them are found at the Norwegian Polar Institute's photo library in Tromsø.

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Habitat choice and community dynamics of zooplankton in the subarctic lakes Takvatn and Lombola (northern Norway).

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On the role of immunocompetence and individual condition in reproductive trade-offs. A study of the common eider *Somateria mollissima*.

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Biology and ecology of selected marine cold-water organisms in the Arctic.

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Arctic and alpine plants and their interactions with herbivores – from individuals to the community.

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Skal vi forby gravide å spise mølje? Hva er realisme og hva er overdreven angst for tungt nedbrytbare forurensende forbindelser (persistent organic pollutants) i kostholdet vårt?

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Arctic-alpine lichens and global change: how do ultraviolet radiation and warming affect secondary metabolism, morphological characters and physiological processes?

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Inger Greve Alsos

Conservation biology of the most thermophilous plant species in the Arctic: genetic variation, recruitment and phylogeography in a changing climate.

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Interferometric and high time-resolution observations of naturally enhanced ion-acoustic echoes at the EISCAT Svalbard radar: software radar and incoherent scattering.

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Control of reproduction in salmonids – experimental studies on Arctic charr.

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Compensatory growth and the lipostat: patterns of growth and lipid deposition in Atlantic salmon, *Salmo salar*, L.

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Pål Erik Isachsen

On the ocean circulation of the Arctic Mediterranean: internal large-scale currents and exchanges with the global oceans. University of Bergen (joint supervision with the Norwegian Polar Institute).

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Cathrine Andersen

Surface ocean climate development and heat flux variability in the Nordic Seas and the subpolar North Atlantic during the Holocene. University of Bergen (joint supervision with the Norwegian Polar Institute).

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Dmitry V. Divine

Peculiarities of shore-fast ice formation and destruction in the Kara Sea. University of Bergen (joint supervision with the Norwegian Polar Institute).

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Eva Fuglei

Physiological adaptations of the Arctic fox to High Arctic conditions. University of Oslo (joint supervision with the Norwegian Polar Institute).

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